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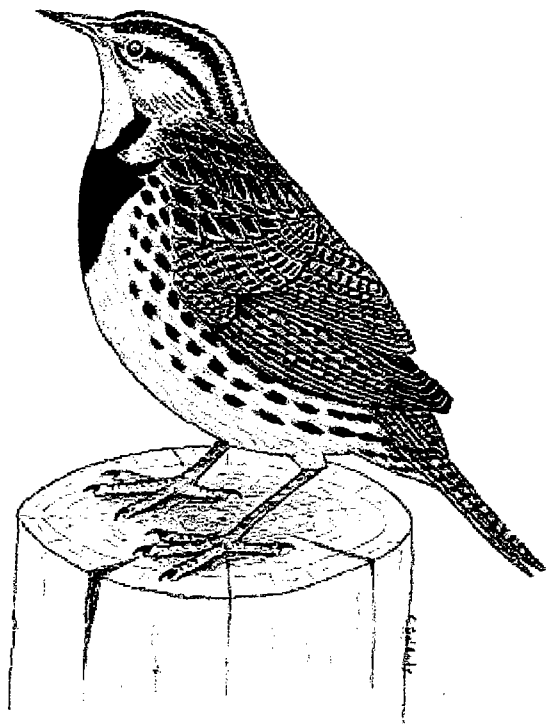
Grassland Bird Inventory for Seven Prairie Parks

Northern Prairie Wildlife Research Center



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Cover: The Eastern Meadowlark is a common breeding bird in grasslands of eastern North America (drawing courtesy of Christopher M. Goldade, Northern Prairie Wildlife Research Center, Jamestown, North Dakota).

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Grassland Bird Inventory of Seven Prairie Parks

by

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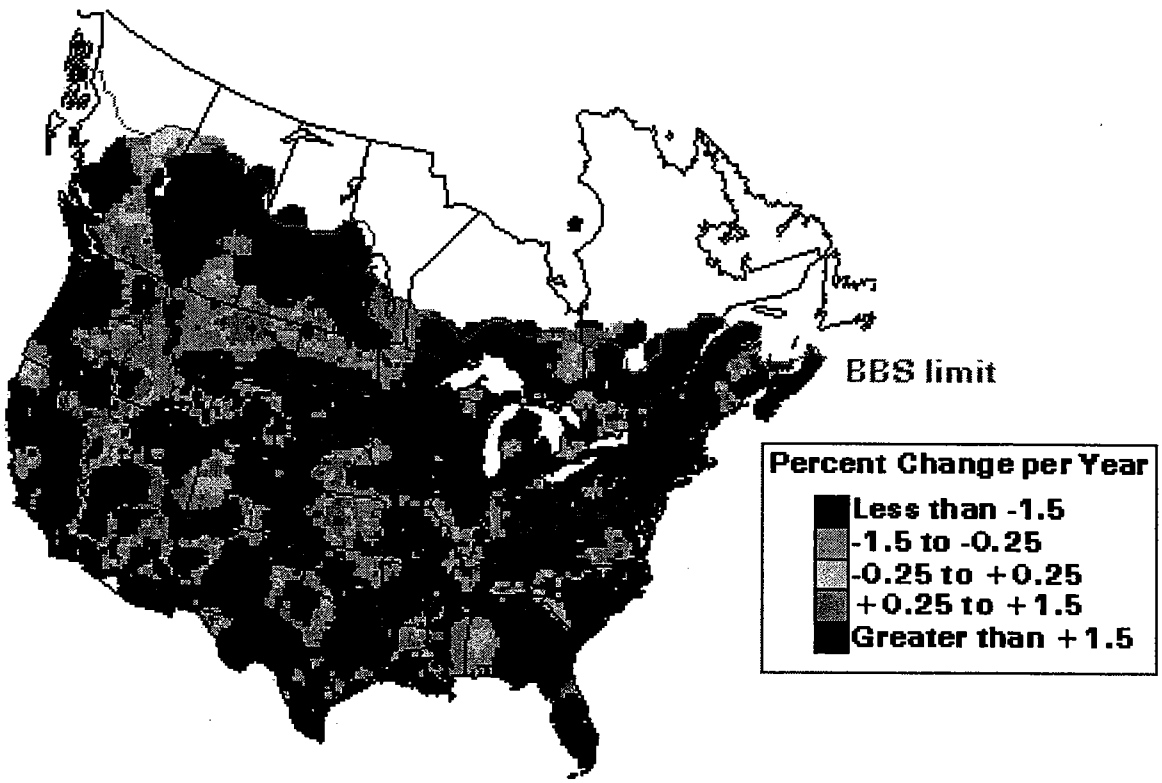
INTRODUCTION

Native prairie in the Midwest and Great Plains has been greatly reduced in area, and remaining prairies are often fragmented (Noss et al. 1995, Knopf and Samson 1997). The Great Plains grassland landscape was altered by the conversion of prairie to cropland and pasture, the removal or disappearance of native ungulates, the drainage of wetlands, and an increase in woody vegetation through plantings and fire suppression (Knopf 1994). The patterns of grassland loss and fragmentation have resulted in changes in the abundance and distribution of grassland-associated vertebrates. Over the past 25 years, data from the U.S. Geological Survey's North American Breeding Bird Survey (BBS) indicate that almost 70% of the 29 grassland bird species adequately surveyed showed evidence of declining populations (Figure 1; Knopf 1994, U.S. Department of Interior 1996, Sauer et al. 2000).

In 1997, the National Park Service (NPS) identified grassland birds as a high-priority research need within the Midwest Region of the national park system. The status of grassland birds on prairie parks and other lands managed by the NPS is largely unknown. The development of a long-term monitoring program for grassland birds was identified as an objective to help track populations in the parks. Information on current status and trends is essential for making informed decisions to protect, enhance, or restore grassland bird populations. In this report, I present baseline inventories of grassland birds from surveys that were conducted in 1998 and 1999 at seven NPS park units within the Great Plains region. These included one national battlefield and four national monuments within the Prairie Cluster Long-Term Ecological Monitoring (LTEM) Program: Wilson's Creek National Battlefield (WICR) in Missouri; Homestead National Monument (HOME), Agate Fossil Beds National Monument (AGFO), and Scotts Bluff National Monument (SCBL) in Nebraska; and Pipestone National Monument (PIPE) in Minnesota. In addition, I conducted baseline inventories of grassland birds at Badlands National Park (BADL) in South Dakota and Theodore Roosevelt National Park (THRO) in North Dakota. Avian inventories of Tallgrass Prairie National Preserve in Kansas were presented in a separate report (Lichtenberg and Powell 2000).

Figure 1. Population trends for the grassland-bird guild within North America, 1966 to 1996 (Sauer et al. 2000).



METHODS

In 1998, I used fixed-radius point counts to survey breeding birds at Pipestone National Monument (8 points), Homestead National Monument (9 points), and Wilson's Creek National Battlefield (18 points). In 1999, I surveyed breeding birds at Agate Fossil Beds National Monument (20 points), Scotts Bluff National Monument (33 points), Badlands National Park (67 points), and Theodore Roosevelt National Park (65 points). I distributed point locations throughout and sampled all habitats within the small monuments (AGFO, HOME, PIPE, and SCBL) and battlefield (WICR). Within the large parks (BADL, THRO), I concentrated only on grassland habitats. Points were located at least 250 m apart and their locations were recorded with a Global Positioning System (GPS) (Appendix A). The number of points in each park unit depended on the size of the unit and accessibility by roads and trails. I did not use a stratified random sampling scheme because of logistical constraints.

Birds were surveyed using the point-count method described in Ralph et al. (1993, 1995). Point counts are a standard method used to monitor populations of breeding birds by the U.S. Forest Service and U.S. Fish and Wildlife Service (Ralph et al. 1993, Peterjohn 1994). I assumed all birds found during point counts were breeding because I conducted counts during the peak of the breeding season, and point counts depend on counting singing males (denoting territoriality). I surveyed breeding birds from mid-May through June in 1998 and late-May through mid-July in 1999. Observers recorded all birds seen or heard within a 5-minute period (i.e. 0 to 3 minutes and 3 to 5 minutes) within a 100-m radius of each survey point (Appendix B; Ralph et al. 1993, 1995). Observers estimated the distance (i.e. 0 to 50 m and 51 to 100 m) to each stationary bird and recorded the number of birds flying overhead (Appendix B). In 1999, at the request of the NPS, observers also estimated the distances of each stationary bird heard or seen from the center of the point for future analysis of detection rates. The results I report, however, are summarized for only birds seen or heard within a 100-m radius because our distance estimates, particularly for those birds that were heard but not seen, were inconsistent and inaccurate.

Only trained observers proficient at bird identification by sight and sound performed counts (Kepler and Scott 1981). Observers started counts within 0.5 hour of local sunrise and ended no later than 0930 CST. Counts were not conducted in rain, high wind, or other inclement weather that could affect detection of birds. Observers noted (i.e., included on lists of avian species) raptors, swallows, nightjars, and waterbirds but did not include them in quantitative data because the methods were not appropriate to survey these species (Ralph et al. 1995). For each park unit, I calculated relative abundance as the total number of individuals per species observed on all point counts divided by the grand total of all individuals of all species observed on all point counts. Observers also conducted informal surveys by slowly walking through the habitats within the park and listening and watching for rare species. In addition, all birds seen or heard outside of points at each park were recorded to aid in the development of bird species checklists.

Finally, I present my data along with U.S. Geological Survey's BBS trends for corresponding physiographic regions (Peterjohn 1994, Sauer et al. 2000). Although BBS data

may not be statistically rigorous for some species in some regions, trends may point towards general declines in some avian populations (Sauer et al. 2000). Tables in this report show estimated population trends (percent increase or decline per year) and a measure of their statistical significance (* = $P < 0.05$, ** = $P < 0.01$), and species are listed in taxonomic order (AOU 1998). BBS trends for those species with major data deficiencies (i.e., small sample size) within a region are not included in this report (Sauer et al. 2000).

RESULTS

Wilson's Creek National Battlefield

Observers recorded 748 individuals of 54 species during point counts at Wilson's Creek, and noted 62 species overall (Table 1). Of the breeding bird species found on point counts, only 6 (11%) were grassland-associated (Table 2). Brown-headed Cowbird was the most abundant species, followed by Indigo Bunting, American Goldfinch, Northern Cardinal, Field Sparrow, and Yellow-breasted Chat. Wilson's Creek also supported Grasshopper Sparrow and Dickcissel, two grassland species showing overall declines on the BBS in the U.S. (Knopf 1994). Within the Osage Plains physiographic region, Northern Bobwhite and Eastern Meadowlark show significant population declines on the BBS, and we found both species at Wilson's Creek (Table 2).

Homestead National Monument

Observers recorded 487 individuals of 44 species during point counts at Homestead in 1998, and noted 46 species overall (Table 1). Six (13%) species on point counts were grassland-associated (Table 3). In descending order, the most abundant species on point counts were Dickcissel, Brown-headed Cowbird, American Goldfinch, House Wren, Common Yellowthroat, Northern Bobwhite, Indigo Bunting, and Blue Jay (Table 3). No grassland bird species showing significant population declines in the High Plains Border physiographic region of the BBS (Sauer et al. 2000) were noted at Homestead. Dickcissel, the most abundant species at the monument, has shown significant population increases in the region (Table 3).

Table 1. List of avian species found at one national battlefield and two national monuments in 1998.

Common name	Scientific name	WICR[a]	HOME[a]	PIPE[a]
Great Blue Heron	*Ardea herodias*	√		
Green Heron	*Butorides virescens*	√		
Yellow-crowned Night-heron	*Nyctanassa violacea*	√		
Turkey Vulture	*Cathartes aura*	√		
Mallard	*Anas platyrhynchos*			√
Wood Duck	*Aix sponsa*			√
Unidentified Teal	*Anas spp.*	√		
Red-tailed Hawk	*Buteo jamaicensis*	√	√	
American Kestrel	*Falco sparverius*	√		
# Ring-necked Pheasant[b,c]	*Phasianus colchicus*		√	√
Northern Bobwhite	*Colinus virginianus*	√	√	
Wild Turkey	*Meleagris gallopavo*	√		
Killdeer	*Charadrius vociferous*			√
American Woodcock	*Scolopax minor*	√		
Mourning Dove	*Zenaida macroura*	√	√	√
Yellow-billed Cuckoo	*Coccyzus americanus*	√		
Common Nighthawk	*Chordeiles minor*	√		√
Chimney Swift	*Chaetura pelagica*		√	√
Ruby-throated Hummingbird	*Archilochus colubris*	√		
Belted Kingfisher	*Ceryle alcyon*			√
Hairy Woodpecker	*Picoides villosus*	√		√
Downy Woodpecker	*Picoides pubescens*	√	√	√
Pileated Woodpecker	*Dryocopus pileatus*	√		
Red-headed Woodpecker	*Melanerpes erythrocephalus*	√	√	
Red-bellied Woodpecker	*Melanerpes carolinus*	√	√	
Northern Flicker	*Colaptes auratus*	√	√	√
Eastern Kingbird	*Tyrannus tyrannus*		√	√
Great-crested Flycatcher	*Myiarchus crinitus*	√	√	
Eastern Phoebe	*Sayornis phoebe*	√	√	√
Eastern Wood-peewee	*Contopus virens*	√	√	
Least Flycatcher	*Empidonax minimus*			√
Acadian Flycatcher	*Empidonax virescens*	√		
Red-eyed Vireo	*Vireo olivaceus*	√	√	√
Warbling Vireo	*Vireo gilvus*		√	
Yellow-throated Vireo	*Vireo flavifrons*	√	√	
White-eyed Vireo	*Vireo griseus*	√		
Blue Jay	*Cyanocitta cristata*	√	√	√
American Crow	*Corvus brachyrhynchos*	√	√	√
Barn Swallow	*Hirundo rustica*	√	√	√
Tree Swallow	*Tachycineta bicolor*			√
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	√		√
Tufted Titmouse	*Baeolophus bicolor*	√	√	
Black-capped Chickadee	*Poecile atricapillus*		√	
Carolina Chickadee	*Poecile carolinensis*	√		
White-breasted Nuthatch	*Sitta carolinensis*	√	√	
Carolina Wren	*Thryothorus ludovicianus*	√	√	

Table 1, continued.

Common name	Scientific name	WICR[a]	HOME[a]	PIPE[a]
House Wren	*Troglodytes aedon*	√	√	√
Sedge Wren	*Cistothorus platensis*			√
Blue-gray Gnatcatcher	*Polioptila caerulea*	√	√	
Gray Catbird	*Dumetella carolinensis*		√	√
Brown Thrasher	*Toxostoma rufum*	√	√	√
American Robin	*Turdus migratorius*	√	√	√
Eastern Bluebird	*Sialia sialis*		√	√
Cedar Waxwing	*Bombycilla cedrorum*			√
# European Starling	*Sturnus vulgaris*		√	√
Black-and-white Warbler	*Mniotilta varia*	√		
Northern Parula	*Parula americana*	√		
Yellow Warbler	*Dendroica petechia*	√	√	√
Magnolia Warbler	*Dendroica magnolia*	√		
Kentucky Warbler	*Oporornis formosus*	√		
Common Yellowthroat	*Geothlypis trichas*	√	√	√
Yellow-breasted Chat	*Icteria virens*	√	√	
Hooded Warbler	*Wilsonia citrina*	√		
Summer Tanager	*Piranga rubra*	√		
Savannah Sparrow	*Passerculus sandwichensis*			√
Grasshopper Sparrow	*Ammodramus savannarum*	√		√
Field Sparrow	*Spizella pusilla*	√		√
Clay-colored Sparrow	*Spizella pallida*			√
Lark Sparrow	*Chondestes grammacus*			√
Dark-eyed Junco	*Junco hyemalis*	√		
Song Sparrow	*Melospiza melodia*	√	√	√
Eastern Towhee	*Pipilo erythrophthalmus*	√		√
Rose-breasted Grosbeak	*Pheucticus ludovicianus*		√	
Blue Grosbeak	*Guiraca caerulea*	√		
Northern Cardinal	*Cardinalis cardinalis*	√	√	√
Indigo Bunting	*Passerina cyanea*	√	√	
Dickcissel	*Spiza americana*	√	√	√
Bobolink	*Dolichonyx oryzivorus*			√
Red-winged Blackbird	*Agelaius phoeniceus*	√	√	√
Western Meadowlark	*Sturnella neglecta*		√	√
Eastern Meadowlark	*Sturnella magna*	√		
Common Grackle	*Quiscalus quiscula*	√	√	√
Brown-headed Cowbird	*Molothrus ater*	√	√	√
Baltimore Oriole	*Icterus galbula*		√	
House Finch	*Carpodacus mexicanus*		√	
American Goldfinch	*Carduelis tristis*	√	√	√
# House Sparrow	*Passer domesticus*		√	√
	Number of species	**62**	**46**	**46**

[a] WICR = Wilson's Creek National Battlefield, HOME = Homestead National Monument, PIPE = Pipestone National Monument

[b] Shaded species are grassland-associated

[c] # = exotic species.

Table 2. Number, relative abundance (percent of total), and regional trend of birds counted within 100-m radius points at Wilson's Creek National Battlefield, 1998.

Species[a,b]	Total birds within 100 m	Relative abundance (%)	Regional Trend[c]
Yellow-crowned Night-heron	1	0.1	—
Turkey Vulture	1	0.1	-0.2
Red-tailed Hawk	3	0.4	2.4*
American Kestrel	1	0.1	0
Northern Bobwhite	6	0.8	-2.6**
Wild Turkey	1	0.1	10.4
American Woodcock	1	0.1	—
Mourning Dove	5	0.7	0.1
Yellow-billed Cuckoo	13	1.7	-1.8*
Common Nighthawk	1	0.1	-2.8*
Ruby-throated Hummingbird	2	0.3	4.5
Hairy Woodpecker	1	0.1	-9.5
Downy Woodpecker	15	2.0	1.4
Pileated Woodpecker	2	0.3	2.0
Red-headed Woodpecker	1	0.1	-8.3**
Red-bellied Woodpecker	8	1.1	1.1
Northern Flicker	1	0.1	-5.6**
Great-crested Flycatcher	6	0.8	0.5
Eastern Phoebe	5	0.7	4.8**
Eastern Wood-peewee	4	0.5	0.5
Acadian Flycatcher	6	0.8	2.8
Barn Swallow	4	0.5	0
Northern Rough-winged Swallow	1	0.1	5.9
Blue Jay	12	1.6	1.2
American Crow	24	3.2	2.8**
Tufted Titmouse	22	2.9	2.2*
Carolina Chickadee	26	3.5	2.9
White-breasted Nuthatch	2	0.3	3.5
Carolina Wren	15	2.0	17.2**
House Wren	2	0.3	6.4*
Brown Thrasher	6	0.8	-3.9**
Blue-gray Gnatcatcher	10	1.3	5.9
Yellow-throated Vireo	1	0.1	—
White-eyed Vireo	13	1.7	—
Black-and-white Warbler	9	1.2	-0.3
Northern Parula	14	1.9	6.5
Yellow Warbler	1	0.1	—
Magnolia Warbler	1	0.1	—
Kentucky Warbler	1	0.1	-2.6
Common Yellowthroat	23	3.1	3.3*
Yellow-breasted Chat	37	5.0	6.5
Grasshopper Sparrow	6	0.8	0.7
Field Sparrow	44	5.9	3.0*

Table 2, continued.

Species[a,b]	Total birds within 100 m	Relative abundance (%)	Regional Trend[c]
Dark-eyed Junco	6	0.8	—
Song Sparrow	1	0.1	—
Eastern Towhee	32	4.3	2.1
Northern Cardinal	59	7.9	2.9**
Blue Grosbeak	2	0.3	-0.6
Indigo Bunting	73	9.8	2.7*
Dickcissel	25	3.3	1.0
Brown-headed Cowbird	118	15.8	-1.4
Eastern Meadowlark	12	1.6	-2.8**
Common Grackle	2	0.3	-3.9**
American Goldfinch	60	8.0	2.3*
Total	**747**	**100**	

[a] shaded species are grassland-associated

[b] # = exotic.

[c] Population trends are from the Osage Plains physiographic region of the North American Breeding Bird Survey, 1980 to1999 (Sauer et al. 2000). * $P < 0.05$, ** $P < 0.01$

Table 3. Number, relative abundance (percent of total), and regional trend of birds counted within 100-m radius points at Homestead National Monument, 1998.

Species[a,b]	Total birds with 100 m	Relative abundance (%)	Regional Trend[c]
# Ring-necked Pheasant	5	1.0	-1.5
Northern Bobwhite	24	4.9	1.5
Morning Dove	9	1.8	-1.7*
Chimney Swift	1	0.2	-1.6
Downy Woodpecker	2	0.4	5.3*
Red-headed Woodpecker	6	1.2	-0.7
Red-bellied Woodpecker	5	1.0	6.7
Northern Flicker	7	1.4	-1.9
Eastern Kingbird	2	0.4	-1.8
Great-crested Flycatcher	4	0.8	5.9
Eastern Phoebe	1	0.2	4.9
Eastern Wood-peewee	6	1.2	—
Barn Swallow	5	1.0	-2.1**
Blue Jay	14	2.9	1.0
American Crow	8	1.6	3.7
Tufted Titmouse	2	0.4	11.9
Black-capped Chickadee	6	1.2	2.4
White-breasted Nuthatch	4	0.8	8.5
Carolina Wren	1	0.2	—
House Wren	43	8.8	4.0
Gray Catbird	6	1.2	-1.4
Brown Thrasher	3	0.6	0
American Robin	3	0.6	1.9*
Eastern Bluebird	1	0.2	6.0
Blue-gray Gnatcatcher	1	0.2	—
# European Starling	6	1.2	-3.3*
Red-eyed Vireo	2	0.4	—
Warbling Vireo	2	0.4	1.9
Yellow-throated Vireo	1	0.2	—
Yellow Warbler	6	1.2	2.3
Common Yellowthroat	27	5.5	-0.6
Yellow-breasted Chat	2	0.4	—
Song Sparrow	9	1.8	—
Northern Cardinal	10	2.1	2.2
Rose-breasted Grosbeak	2	0.4	-2.6
Indigo Bunting	14	2.9	9.7
Dickcissel	87	17.9	2.4**
Brown-headed Cowbird	65	13.3	1.7*
Red-winged Blackbird	8	1.6	-0.3
Western Meadowlark	7	1.4	-0.7
Baltimore Oriole	7	1.4	-1.3
Common Grackle	3	0.6	-1.7
# House Finch	2	0.4	—
American Goldfinch	58	11.9	1.8
Total	**487**	**100**	

[a] shaded species are grassland-associated

[b] # = exotic,

[c] Population trends are from the High Plains Border physiographic region of the North American BBS, 1980 to 1999 (Sauer et al. 2000), * $P < 0.05$, ** $P < 0.01$

Pipestone National Monument

Observers recorded a total of 373 individuals of 30 species at Pipestone during point counts in 1998, and recorded 46 species overall (Table 1). Ten species (33%) of breeding birds were grassland-associated (Table 4). The most abundant species, in descending order, were Common Grackle, Red-winged Blackbird, American Robin, Western Meadowlark, Brown-headed Cowbird, Bobolink, Common Yellowthroat, and Dickcissel (Table 4). Of the three park units sampled in 1998 (PIPE, HOME, WICR), Pipestone had the highest proportion of grassland habitats and thus the highest proportion of grassland birds. Of the grassland species that have shown significant declining population trends on BBS routes in the Black Prairie physiographic region (Sauer et al. 2000), Pipestone supported breeding Western Meadowlarks, Bobolinks, and Red-winged Blackbirds (Table 4).

Agate Fossil Beds National Monument

Observers recorded 203 individual birds of 20 species at Agate Fossil Beds during point counts in 1999, and found 50 species overall (Table 5). Twelve species (60%) of breeding birds were grassland-associated (Table 6). The most abundant species, in descending order, included Western Meadowlark, Lark Bunting, Grasshopper Sparrow, Red-winged Blackbird, and Lark Sparrow. Grasshopper Sparrows and Lark Sparrows have shown significant population declines in the High Plains physiographic region of the BBS since 1980 (Table 6). Although Ring-necked Pheasants also have experienced declines in the region, they are introduced exotics.

Scotts Bluff National Monument

Observers recorded 232 individuals of 36 species at Scotts Bluff during point counts in 1999, and recorded 64 species overall (Table 5). Eight (22%) species were grassland-associated (Table 7). The most abundant species on point counts were Western Meadowlark, Common Grackle, Spotted Towhee, Black-billed Magpie, and Brown-headed Cowbird. Western Meadowlarks and Common Grackles combined constituted 49% of all individuals.

Table 4. Number, relative abundance (percent of total), and regional trend of birds counted within 100-m radius points at Pipestone National Monument, 1998.

Species[a,b]	Total birds within 100 m	Relative abundance (%)	Regional trend[c]
Wood Duck	1	0.3	—
# Ring-necked Pheasant	17	4.6	-2.2
Killdeer	1	0.3	0
Morning Dove	9	2.4	-2.8**
Northern Flicker	2	0.5	-7.4**
Red-eyed Vireo	1	0.3	5.0
Tree Swallow	6	1.6	5.6
Blue Jay	5	1.3	0.7
American Crow	5	1.3	1.2
House Wren	4	1.1	-0.2
Gray Catbird	4	1.1	1.5
Brown Thrasher	4	1.1	-3.5
American Robin	32	8.6	0
Cedar Waxwing	12	3.2	4.6
# European Starling	4	1.1	-4.1
Common Yellowthroat	21	5.6	-1.8
Savannah Sparrow	1	0.3	1.8
Grasshopper Sparrow	3	0.8	-5.9
Clay-colored Sparrow	8	2.2	1.0
Field Sparrow	3	0.8	—
Song Sparrow	17	4.6	-0.1
Eastern Towhee	1	0.3	33.0
Dickcissel	19	5.1	-3.2
Bobolink	22	5.9	-4.2**
Brown-headed Cowbird	23	6.2	-2.1
Red-winged Blackbird	34	9.1	-2.8*
Western Meadowlark	27	7.3	-4.3**
Baltimore Oriole	2	0.5	0.6
Common Grackle	71	19.1	-1.9
American Goldfinch	14	3.8	1.0
Total	**373**	**100**	

[a] shaded species are grassland-associated

[b] # = exotic

[c] Regional population trends are from the Black Prairie physiographic region of the North American Breeding Bird Survey, 1980 to 1999 (Sauer et. al. 2000), * $P < 0.05$, ** $P < 0.01$

Table 5. List of avian species found at two national parks and two national monuments in 1999.

Common name	Scientific name	AGFO[a]	SCBL[a]	BADL[a]	THRO[a]
American White Pelican	*Pelecanus erythrorhynchos*			√	√
Great Blue Heron	*Ardea herodias*	√			√
Great Egret	*Ardea alba*		√		
Black-crowned Night-Heron	*Nycticorax nycticorax*			√	
Turkey Vulture	*Cathartes aura*		√	√	√
Canada Goose	*Branta canadensis*			√	√
Wood Duck	*Aix sponsa*	√			
Mallard	*Anas platyrhynchos*	√	√	√	√
Blue-winged Teal	*Anas discors*			√	
Green-winged Teal	*Anas crecca*			√	
Northern Harrier[b]	*Circus cyaneus*			√	√
Sharp-shinned Hawk	*Accipiter striatus*				√
Swainson's Hawk	*Buteo swainsoni*			√	√
Red-tailed Hawk	*Buteo jamaicensis*	√	√	√	
Golden Eagle	*Aquila chrysaetos*				√
American Kestrel	*Falco sparverius*	√	√	√	√
Prairie Falcon	*Falco mexicanus*		√	√	
# Ring-necked Pheasant[c]	*Phasianus colchicus*	√	√		√
Sharp-tailed Grouse	*Tympanuchus phasianellus*			√	√
Greater Prairie-Chicken	*Tympanuchus cupido*	√			
Wild Turkey	*Meleagris gallopavo*	√	√	√	√
Northern Bobwhite	*Colinus virginianus*	√	√		
Killdeer	*Charadrius vociferus*	√	√	√	√
Spotted Sandpiper	*Actitis macularia*				√
Upland Sandpiper	*Bartramia longicauda*	√		√	√
Long-billed Curlew	*Numenius americanus*			√	
Wilson's Phalarope	*Phalaropus tricolor*			√	√
Rock Dove	*Columba livia*	√	√	√	√
Mourning Dove	*Zenaida macroura*	√	√	√	√
Black-billed Cuckoo	*Coccyzus erythropthalmus*		√		√
Yellow-billed Cuckoo	*Coccyzus americanus*		√	√	
Great Horned Owl	*Bubo virginianus*				√
Burrowing Owl	*Athene cunicularia*			√	
Short-eared Owl	*Asio flammeus*	√	√		
Common Nighthawk	*Chordeiles minor*	√		√	√
Chimney Swift	*Chaetura pelagica*		√		
White-throated Swift	*Aeronautes saxatalis*			√	
Belted Kingfisher	*Ceryle alcyon*		√	√	
Downy Woodpecker	*Picoides pubescens*		√		√
Hairy Woodpecker	*Picoides villosus*		√		
Northern Flicker	*Colaptes auratus*	√	√	√	√
Western Wood-Pewee	*Contopus sordidulus*		√		
Eastern Phoebe	*Sayornis phoebe*		√		
Say's Phoebe	*Sayornis saya*	√	√	√	√
Cassin's Kingbird	*Tyrannus vociferans*	√	√		
Western Kingbird	*Tyrannus verticalis*	√	√	√	√

Table 5, continued.

Common name	Scientific name	AGFO[a]	SCBL[a]	BADL[a]	THRO[a]
Eastern Kingbird	*Tyrannus tyrannus*	√	√	√	√
Loggerhead Shrike	*Lanius ludovicianus*	√		√	√
Bell's Vireo	*Vireo bellii*			√	
Red-eyed Vireo	*Vireo olivaceus*				√
Black-billed Magpie	*Pica pica*		√	√	
American Crow	*Corvus brachyrhynchos*	√		√	√
Horned Lark	*Eremophila alpestris*	√		√	
Tree Swallow	*Tachycineta bicolor*				√
Violet-green Swallow	*Tachycineta thalassina*		√		
Northern Rough-winged	*Stelgidopteryx serripennis*	√	√	√	√
Bank Swallow	*Riparia riparia*	√			√
Cliff Swallow	*Petrochelidon pyrrhonota*	√		√	√
Barn Swallow	*Hirundo rustica*	√	√	√	√
Black-capped Chickadee	*Poecile atricapillus*		√	√	√
Tufted Titmouse	*Baeolophus bicolor*				√
White-breasted Nuthatch	*Sitta carolinensis*		√		√
Rock Wren	*Salpinctes obsoletus*	√	√	√	√
House Wren	*Troglodytes aedon*		√	√	√
Blue-gray Gnatcatcher	*Polioptila caerulia*		√		
Western Bluebird	*Sialia mexicana*		√		
Mountain Bluebird	*Sialia currucoides*		√	√	√
Swainson's Thrush	*Catharus ustulatus*				√
American Robin	*Turdus migratorius*		√	√	√
Brown Thrasher	*Toxostoma rufum*	√	√	√	√
# European Starling	*Sturnus vulgaris*	√	√		√
Sprague's Pipit	*Anthus spragueii*			√	
Cedar Waxwing	*Bombycilla cedrorum*			√	√
Orange-crowned Warbler	*Vermivora celata*			√	
Yellow Warbler	*Dendroica petechia*		√	√	√
Yellow-rumped Warbler	*Dendroica coronata*			√	√
Black-and-white Warbler	*Mniotilta varia*				√
Ovenbird	*Seiurus aurocapillus*				√
Northern Waterthrush	*Seiurus noveboracensis*				√
Common Yellowthroat	*Geothlypis trichas*	√			√
Yellow-breasted Chat	*Icteria virens*		√	√	√
Spotted Towhee	*Pipilo maculatus*	√	√	√	√
Chipping Sparrow	*Spizella passerina*		√	√	√
Clay-colored Sparrow	*Spizella pallida*	√		√	√
Field Sparrow	*Spizella pusilla*		√	√	√
Vesper Sparrow	*Pooecetes gramineus*	√	√	√	√
Lark Sparrow	*Chondestes grammacus*	√	√	√	√
Lark Bunting	*Calamospiza melanocorys*	√	√	√	
Savannah Sparrow	*Passerculus sandwichensis*		√		√
Grasshopper Sparrow	*Ammodramus savannarum*	√	√	√	√
Baird's Sparrow	*Ammodramus bairdii*				√
Song Sparrow	*Melospiza melodia*			√	

Table 5, continued.

Common name	Scientific name	AGFO[a]	SCBL[a]	BADL[a]	THRO[a]
Harris's Sparrow	*Zonotrichia querula*				√
White-crowned Sparrow	*Zonotrichia leucophrys*			√	√
Chestnut-collared Longspur	*Calcarius ornatus*	√		√	
Black-headed Grosbeak	*Pheucticus melanocephalus*	√	√		√
Blue Grosbeak	*Guiraca caerulea*	√	√	√	√
Lazuli Bunting	*Passerina amoena*	√		√	√
Indigo Bunting	*Passerina cyanea*		√		
Dickcissel	*Spiza*		√	√	√
Common Grackle	*Quiscalus quiscula*	√	√	√	√
Brown-headed Cowbird	*Molothrus ater*	√	√	√	√
Orchard Oriole	*Icterus spurius*	√	√	√	
Baltimore Oriole	*Icterus galbula*	√	√		
Bullock's Oriole	*Icterus bullockii*		√		
Purple Finch	*Carpodacus purpureus*				√
Pine Siskin	*Carduelis pinus*				√
American Goldfinch	*Carduelis tristis*	√	√	√	√
# House Sparrow	*Passer domesticus*		√	√	
Total number of species	**50**	**64**	**72**	**76**	

[a] AGFO = Agate Fossil Beds National Monument, SCBL = Scotts Bluff National Monument, BADL = Badlands National Park, THRO = Theodore Roosevelt National Park.
[b] Shaded species are grassland-associated
[c] # = exotic species.

Table 6. Number, relative abundance (percent of total), and regional trend of breeding birds counted within 100-m radius points at Agate Fossil Beds National Monument, 1999.

Species[a,b]	Total birds within 100 m	Relative abundance (%)	Regional trend[c]
# Ring-necked Pheasant	1	0.5	-3.5*
Killdeer	1	0.5	-1.9
Mourning Dove	3	1.5	1.1
Cassin's Kingbird	2	1.0	—
Horned Lark	1	0.5	-1.5
Barn Swallow	4	2.0	-2.0**
Northern Rough-winged Swallow	2	1.0	—
Rock Wren	2	1.0	0.1
# European Starling	2	1.0	4.7**
Common Yellowthroat	4	2.0	3.9*
Vesper Sparrow	4	2.0	-1.5
Grasshopper Sparrow	33	16.3	-3.2*
Clay-colored Sparrow	1	0.5	—
Lark Sparrow	12	5.9	-4.3*
Lark Bunting	41	20.2	-2.1
Chestnut-collared Longspur	3	1.5	—
Dickcissel	1	0.5	11.1*
Red-winged Blackbird	20	9.9	2.4*
Western Meadowlark	63	31.0	0.7
Brown-headed Cowbird	3	1.5	3.5
Total	**203**	**100**	

[a] shaded species are grassland-associated

[b] # = exotic.

[c] Population trends are from the High Plains physiographic region of the North American Breeding Bird Survey, 1980 to 1999 (Sauer et al. 2000), * $P < 0.05$, ** $P < 0.01$

recorded at this monument (Table 7). Scotts Bluff supported Lark Sparrows, which have declined significantly in the High Plains physiographic region since 1980 (Table 7).

Badlands National Park

Observers recorded a total of 703 individuals of 38 species on point counts in 1999, and saw 72 species overall (Table 5). Of the breeding birds found on point counts, 14 (37%) were grassland-associated, and of all the individual birds within point counts, 51% were Western Meadowlarks (Table 8). The next most abundant species were Red-winged Blackbird, Grasshopper Sparrow, Brown-headed Cowbird, Dickcissel, and Spotted Towhee. Badlands National Park supported Burrowing Owls, Chestnut-collared Longspurs, and Horned Larks, all of which have had significant population declines in the Great Plains Roughlands physiographic region since 1980 (Table 8).

Theodore Roosevelt National Park:

Observers recorded 650 individuals of 39 species at Theodore Roosevelt during point counts in 1999 and saw 76 species overall (Table 5). Twelve (31%) of the breeding species found on point counts were grassland-associated (Table 9). The most abundant species, in descending order, were Spotted Towhee, Western Meadowlark, Vesper Sparrow, Field Sparrow, and Yellow-breasted Chat. Of the grassland-associated species showing significant declines in the Great Plains Roughlands physiographic region since 1980, Theodore Roosevelt supported Upland Sandpipers, although in small numbers (Table 9).

Table 7. Number, relative abundance (percent of total), and regional trend of breeding birds counted within 100-m radius points at Scotts Bluff National Monument, 1999.

Species[a,b]	Total birds within 100 m	Relative abundance (%)	Regional trend[c]
American Kestrel	2	0.9	-1.0
# Ring-necked Pheasant	4	1.7	-3.5*
Northern Bobwhite	2	0.9	—
Killdeer	1	0.4	-1.9
Rock Dove	4	1.7	—
Mourning Dove	1	0.4	1.1
Belted Kingfisher	1	0.4	—
Downy Woodpecker	1	0.4	—
Yellow-shafted Flicker	1	0.4	5.0
Eastern Kingbird	3	1.3	-0.9
Western Kingbird	1	0.4	0.9
Black-billed Magpie	14	6.0	-2.8
Blue Jay	1	0.4	-2.5
Northern Rough-winged Swallow	3	1.3	—
Black-capped Chickadee	4	1.7	—
White-breasted Nuthatch	1	0.4	—
House Wren	4	1.7	10.8**
Rock Wren	3	1.3	0.1
Blue-gray Gnatcatcher	3	1.3	—
Brown Thrasher	2	0.9	—
# European Starling	2	0.9	4.7**
Yellow-rumped Warbler	1	0.4	—
Yellow-breasted Chat	8	3.4	—
Spotted Towhee	16	6.9	—
Grasshopper Sparrow	4	1.7	-3.2
Chipping Sparrow	7	3.0	—
Lark Sparrow	1	0.4	-4.3*
Blue Grosbeak	4	1.7	8.6*
Black-headed Grosbeak	1	0.4	—
Lazuli Bunting	1	0.4	—
Dickcissel	1	0.4	11.1*
Red-winged Blackbird	2	0.9	2.4*
Western Meadowlark	83	35.8	0.7
Common Grackle	30	12.9	-1.2
Brown-headed Cowbird	14	6.0	3.5
American Goldfinch	1	0.4	9.0*
Total	**232**	**100**	

[a] shaded species are grassland-associated

[b] # = exotic.

[c] Population trends are from the High Plains physiographic region of the North American Breeding Bird Survey, 1980 to 1999 (Sauer et al. 2000), * $P < 0.05$, ** $P < 0.01$

Table 8. Number, relative abundance (percent of total), and regional trend of breeding birds counted within 100-m radius points at Badlands National Park, 1999.

Species[a,b]	Total birds within 100 m	Relative abundance	Regional trend[c]
American Kestrel	3	0.4	-4.0*
Mourning Dove	18	2.6	-2.2**
Rock Dove	1	0.1	-0.1
Burrowing Owl	1	0.1	-12.3*
Yellow-billed Cuckoo	1	0.1	—
Eastern Kingbird	14	2.0	1.5*
Say's Phoebe	5	0.7	0.9
Western Kingbird	1	0.1	3.2**
Bell's Vireo	8	1.1	—
American Crow	5	0.7	3.2
Horned Lark	1	0.1	-3.5**
Cliff Swallow	2	0.3	3.2
Northern Rough-winged Swallow	2	0.3	—
Black-capped Chickadee	5	0.7	0.3
House Wren	10	1.4	3.5**
Rock Wren	10	1.4	-5.5**
Mountain Bluebird	2	0.3	-3.3
American Robin	1	0.1	0.5
Brown Thrasher	4	0.6	0.5
European Starling *	3	0.4	-1.6
Yellow Warbler	5	0.7	4.6*
Spotted Towhee	20	2.8	4.4
Field Sparrow	5	0.7	6.6
Vesper Sparrow	4	0.6	-1.2
Grasshopper Sparrow	62	8.8	-2.4
Clay-colored Sparrow	4	0.6	6.4
Lark Sparrow	7	1.0	-0.2
Chestnut-collared Longspur	1	0.1	-6.0*
Blue Grosbeak	2	0.3	-6.2
Dickcissel	20	2.8	—
Lark Bunting	1	0.1	0.3
Lazuli Bunting	1	0.1	-2.9
Red-winged Blackbird	70	10.0	0.5
Common Grackle	5	0.7	0.5
Western Meadowlark	360	51.2	0.5
Brown-headed Cowbird	37	5.3	3.4**
Orchard Oriole	1	0.1	-0.2
American Goldfinch	1	0.1	5.9*
Total	**703**	**100**	

[a] shaded species are grassland-associated

[b] # = exotic.

[c] Population trends are from the Great Plains Roughlands physiographic region of the Breeding Bird Survey, 1980 to 1999 (Sauer et al. 2000), * $P < 0.05$, ** $P < 0.01$

Table 9. Number, relative abundance (percent of total), and regional trend of breeding birds counted within 100-m radius points at Theodore Roosevelt National Park, 1999.

Species[a,b]	Total birds within 100 m	Relative abundance (%)	Regional trend[c]
Upland Sandpiper	5	0.8	-3.5**
Wilson's Phalarope	5	0.8	0.4
Mourning Dove	19	2.9	-2.2**
Wild Turkey	3	0.5	9.4
Downy Woodpecker	1	0.2	—
Northern Flicker	5	0.8	-0.6
Say's Phoebe	4	0.6	0.9
Red-eyed Vireo	5	0.8	-2.6
American Crow	11	1.7	3.2
Barn Swallow	1	0.2	-0.9
Cliff Swallow	30	4.6	3.2
Black-capped Chickadee	2	0.3	0.3
Eastern Tufted Titmouse	2	0.3	—
House Wren	3	0.5	3.5**
Rock Wren	3	0.5	-5.5**
Mountain Bluebird	5	0.8	-3.3
Cedar Waxwing	3	0.5	—
Black-and-White Warbler	2	0.3	0.2
Ovenbird	1	0.2	—
Yellow Warbler	31	4.8	4.6*
Common Yellowthroat	38	5.8	-0.2
Yellow-breasted Chat	41	6.3	6.8
Spotted Towhee	113	17.4	4.4
Chipping Sparrow	31	4.8	4.4
Clay-colored Sparrow	9	1.4	6.4
Field Sparrow	45	6.9	6.6
Vesper Sparrow	52	8.0	-1.2
Lark Sparrow	19	2.9	-0.2
Lark Bunting	1	0.2	0.3
Savannah Sparrow	1	0.2	-1.5
Grasshopper Sparrow	36	5.5	-2.4
Blue Grosbeak	3	0.5	-6.2
Lazuli Bunting	20	3.1	-2.9
Bobolink	5	0.8	-0.2
Red-winged Blackbird	2	0.3	0.5
Western Meadowlark	60	9.2	0.5
Common Grackle	4	0.6	0.5
Brown-headed Cowbird	10	1.5	3.4**
American Goldfinch	19	2.9	5.9*
Total	**650**	**100**	

[a] shaded species are grassland-associated

[b] # = exotic.

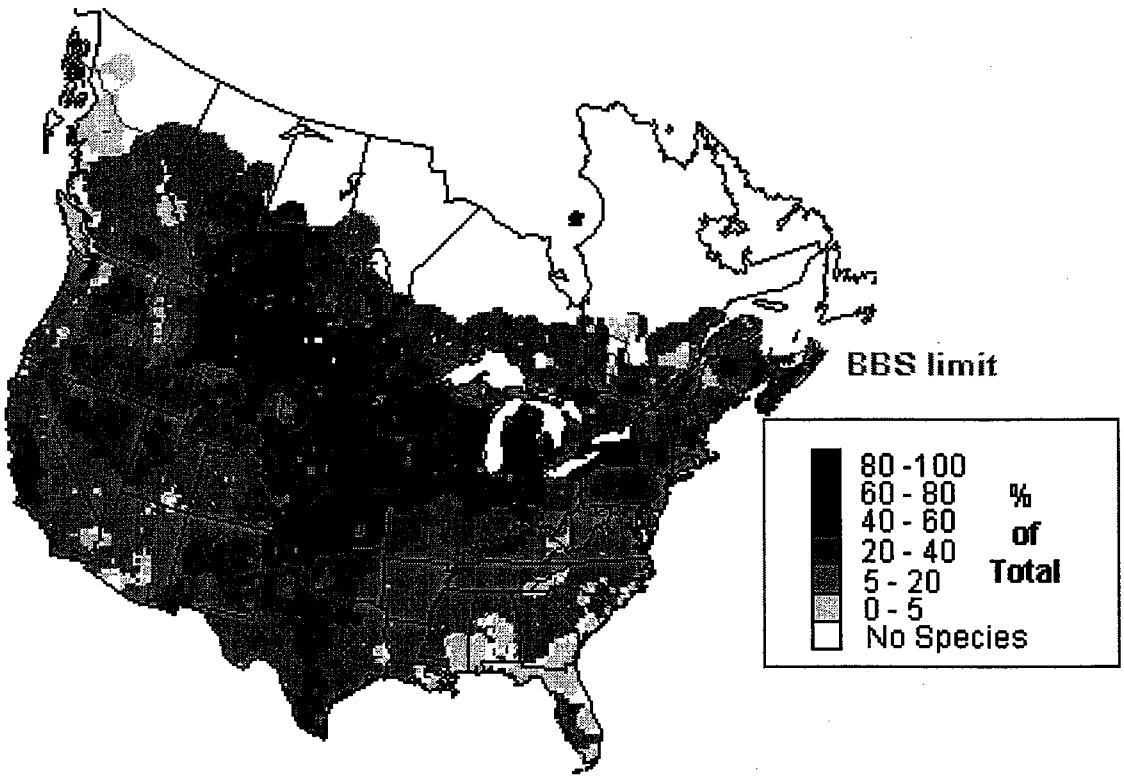
[c] Population trends are from the Great Plains Roughlands physiographic region of the North American Breeding Bird Survey, 1980 to 1999 (Sauer et al. 2000), * $P < 0.05$, ** $P < 0.01$

DISCUSSION

The parks units within the Prairie Cluster LTEM are small in area, and only Agate Fossil Beds National Monument is not surrounded by urban and/or agricultural landscapes. Pipestone National Monument, however, is unique in that it was adjacent to a wildlife management area amenable to breeding grassland birds, and Scotts Bluff National Monument and Agate Fossil Beds have adjacent rangeland. Homestead National Monument and Wilson's Creek National Battlefield are both surrounded primarily by agricultural or urban landscapes, and thus their effective size, in terms of breeding grassland birds, is limited. Grassland birds with low area-sensitivity were common at these small parks: Dickcissel, Northern Bobwhite, Red-winged Blackbird, American Goldfinch, Field Sparrow, and Common Yellowthroat (Herkert et al. 1993). In addition, the most abundant grassland species found at these sites are generally associated with higher densities of shrubs and medium to dense vegetation (Herkert et al. 1993). Agate Fossils Beds had the greatest proportion of grassland bird species (60% of the total number of bird species), probably because the monument consists entirely of grassland habitat (Graetz et al. 1995). Pipestone had the next greatest proportion of grassland birds (33%), and most of this monument consisted of grassland habitats. Scotts Bluff consisted of several habitat types, including woodlands, pine-studded bluffs, and shrub-dominated slopes (Cox and Franklin 1989). Wilson's Creek had the least proportional amount of grassland habitat and grassland birds.

The large national parks, Badlands and Theodore Roosevelt, had relatively high proportions of grassland birds (37% and 33%, respectively), but I did not locate any points in non-grassland habitats at these sites. In addition, the large national parks had greater species richness of grassland birds than the smaller park units. Agate Fossil Beds, however, had similar species richness to Badlands and Theodore Roosevelt (12 species of grassland birds compared to 14 and 12 species, respectively). In general, species richness in grasslands is low (Igl and Johnson 1997). Theodore Roosevelt and Badlands national parks and Agate Fossil Beds and Scotts Bluff national monuments occur in the geographic area with the greatest diversity of breeding grassland birds species within the United States (Figure 2). Given the large size of Badlands and

Figure 2. Species richness of grassland birds within the United States and southern Canada as detected by the North American Breeding Bird Survey (Sauer et al. 2000).



Theodore Roosevelt, adjacent land use, and geographic location, species richness would be expected to be highest for grassland birds at these parks and monuments.

Species with significant declining population trends across North America from 1966 to 1999 include Grasshopper Sparrow, Eastern Meadowlark, Horned Lark, Bobolink, Lark Bunting, and Dickcissel (Sauer et al. 2000). Species showing significant declines on the BBS from 1980 to 1999 include Henslow's Sparrow, Eastern Meadowlark, Chestnut-collared Longspur, Grasshopper Sparrow, Horned Lark, Upland Sandpiper, and Bobolink. Several other grassland birds show declining but non-significant trends for both the 1966 to 1999 and 1980 to 1999 time periods: Northern Harrier, Baird's Sparrow, Short-eared Owl, Western Meadowlark, and Vesper Sparrow. Clearly, the large national parks may influence regional populations of these species. Whether the influence is positive or negative will depend on whether these sites serve as population

sources or sinks (Pulliam 1988, Powell and Collier 1998). Habitat management, including prescribed fire, grazing, and mowing, may be implemented to target specific grassland-bird species to enhance their productivity and, in some cases, increase species richness. Species-specific literature reviews on the effects of management on grassland birds have been distributed to all the parks within this baseline inventory. In addition, updates to these literature reviews are readily accessible from the Northern Prairie Wildlife Research Center Web Site (Johnson and Igl 2000; Appendix C).

PARK-SPECIFIC MONITORING RECOMMENDATIONS

Wilson's Creek National Battlefield

Wilson's Creek does not support large numbers of grassland birds and is unlikely to influence regional populations of grassland birds because of its small size (708.2 ha), limited amount of grassland habitat, and altered surrounding land use. Future monitoring of grassland birds is not recommended at Wilson's Creek.

Homestead National Monument

Homestead is very small (64.8 ha) and is not surrounded by habitats used by most breeding grassland birds. Habitat management for grassland birds at this site would not likely contribute to their regional populations. Future monitoring of grassland bird populations at this monument is not recommended.

Pipestone National Monument

Pipestone is very small (114.1 ha) but supports relatively large numbers of Bobolinks and Western Meadowlarks. Both species show significant declines in the Black Prairie physiographic region of the BBS and are of concern throughout their range. This monument is small enough that a study of the productivity of Bobolinks and Western Meadowlarks within the monument is feasible. An intensive study on nest success would be particularly pertinent given the ongoing program of prescribed burning that is used at Pipestone and that effectively divides the monument into smaller nesting-habitat fragments.

Agate Fossil Beds National Monument

Although Agate Fossil Beds is a small monument (1,236.3 ha), it supports relatively large numbers of grassland birds, several species of which are declining regionally (Grasshopper Sparrow and Lark Sparrow) or continentally (Western Meadowlark and Lark Bunting). This site would make a good candidate for a comparative study of nest success of grassland birds in and adjacent to the monument because grasslands surrounding it are grazed by cattle. In addition, there is a BBS route that crosses the western end of the monument that can provide information on long-term grassland bird population trends in the area (http://www.npwrc.usgs.gov/resource/1998/agate/bird.htm). Finally, an inventory of vertebrates at the monument conducted in 1993 established four 1,000-m transects in four primary habitat types (lowland prairie, upland prairie, riparian/wetland, and rocky bluffs) for monitoring birds (Graetz et al. 1995). These transects could be used in the future to monitor densities of breeding birds and species richness at the monument.

Scotts Bluff National Monument

Scotts Bluff is another monument small in size (1,213.4 ha) and surrounded by range and urban land uses. However, the monument supports several species that have shown declines continentally and/or regionally. Burrowing Owls in the monument should be monitored annually. This species is closely tied to the prairie dog town in the monument, and therefore monitoring of the owl population should use direct counts at that location rather than point counts distributed throughout the monument. The value of monitoring other grassland bird populations at the monument is questionable given the small area of grassland habitats. In the 1980s, three 1,400 m line transects were established to estimate avian density and diversity (Cox and Franklin 1989). As in Agate Fossil Beds, these transects could be used to monitor grassland bird densities and species richness.

Badlands National Park

Badlands had high numbers of grassland birds, especially Western Meadowlarks. Several species found at Badlands are of regional and continental concern, including Burrowing Owl, Horned Lark, Chestnut-collared Longspur, Western Meadowlark, and Grasshopper Sparrow.

Given the park's large size (98,479.5 ha), a long-term monitoring program should be developed using a stratified-random sampling scheme (Bibby et al. 1992). Points should be located in grassland habitats throughout the park. Given the time and resources available, I focused on the areas with easy access along the northern edge of the North Unit and at Sheep Mountain in the South Unit. The logistics of this design need to be considered because of the limited access of much of the park (Stronghold Unit and Sage Creek Wilderness Area). If a monitoring scheme is developed for Badlands, time and expense need to be factored in given the remoteness of areas, limited access, and rugged topography. Species-specific monitoring, such as for Burrowing Owls, should be developed separately. Counts of Burrowing Owls can be associated with monitoring prairie dog towns at the park.

Theodore Roosevelt National Park

As at Badlands, Theodore Roosevelt should develop a long-term monitoring program for grassland birds using a stratified-random sampling scheme focusing on grassland habitats. Again, logistics of sampling design need to be considered given the size (28,508.7 ha) and remoteness of much of the park (south of the Little Missouri River in the North Unit, west of the Little Missouri River in the South Unit). However, much of the remote areas at the park do not consist of grassland habitats. Finally, Theodore Roosevelt has the benefit of an established BBS route that includes some of the North Unit of the park.

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Appendix A. Global Positioning System locations of grassland bird point counts at seven national parks, monuments, and battlefields in the Great Plains, 1998 to1999.

Park	Point number	Easting	Northing	Elevation (m)	Error (m)
AGFO	1	604578	4698312	-	9
AGFO	2	603970	4697723	-	6.3
AGFO	3	603297	4697406	-	9.9
AGFO	4	602492	4697328	-	9.3
AGFO	5	601785	4697245	-	9.9
AGFO	6	601000	4697224	-	10
AGFO	7	601000	4697338	-	11
AGFO	8	599574	4097542	-	4.7
AGFO	9	599864	4697913	1371	6.8
AGFO	10	602692	4696677	1351	10
AGFO	11	601859	4696563	1348	6.4
AGFO	12	601170	4696327	1356	7.6
BADL	MS1	258916	4848812	739	4.3
BADL	MS2	741421	4849290	742	5.1
BADL	MS3	740788	4849886	748	7.9
BADL	MS4	740536	4851692	815	3.6
BADL	MS5	739994	4852200	815	5.3
BADL	MS6	739388	4852672	818	6.6
BADL	MS7	738667	4852638	824	6.1
BADL	MS8	738130	4853230	825	7.3
BADL	MS9	737448	4853059	781	14
BADL	MS10	736407	4853520	825	5.2
BADL	MS11	736048	4852944	821	11
BADL	MS12	735281	4852970	820	5.9
BADL	MS13	734537	4852590	817	5.7
BADL	MS14	733776	4852514	811	4.8
BADL	MS15	733011	4852772	817	5.9
BADL	NE1	265901	4851279	785	9.4
BADL	NE2	265393	4850586	794	4.3
BADL	NE3	264718	4850366	798	6.3
BADL	NE4	264374	4849639	803	6.3
BADL	NE5	264044	4849328	804	4.9
BADL	NE6	263470	4849240	828	10
BADL	NE7	263051	4849975	809	12
BADL	NE8	263052	4850676	788	3.5
BADL	NE9	263071	4851503	792	8.6
BADL	NE10	262834	4847954	745	5.5
BADL	NE11	262308	4848321	746	5.9

Appendix A, continued.

Park	Point number	Easting	Northing	Elevation (m)	Error (m)
BADL	NE12	261665	4848522	746	9.6
BADL	NE13	260928	4848821	735	5.1
BADL	NE14	260170	4849117	741	5.1
BADL	NE15	259709	4848709	746	5.4
BADL	SC1	722373	4861008	977	5.2
BADL	SC2	721676	4861400	943	5
BADL	SC3	720900	4861157	947	4.9
BADL	SC4	720590	4861533	943	4.8
BADL	SC5	719976	4862125	927	4.5
BADL	SC6	716266	4864701	916	5.7
BADL	SC7	715571	4864486	908	46
BADL	SC8	715040	4864284	914	4.1
BADL	SC9	714339	4864439	916	3.9
BADL	SC10	713813	4865001	907	11
BADL	SC11	713661	4865675	908	5.9
BADL	SC12	712418	4865553	905	5.8
BADL	SC13	711840	4864905	855	5.1
BADL	SC14	711003	4864820	836	5.2
BADL	SC15	710569	4865019	838	6.7
BADL	SC16	709845	4864911	839	6.8
BADL	SC17	708879	4865190	827	7.1
BADL	SC18	707975	4864992	775	5.5
BADL	SC19	707943	4864202	776	5.5
BADL	SC20	707819	4863441	778	7.9
BADL	SC21	707071	4864360	794	11
BADL	SC22	706990	4863649	860	7.2
BADL	SC23	706443	4863153	874	7.7
BADL	SM2	697887	4843001	861	5.5
BADL	SM3	697098	4843134	675	6.6
BADL	SM4	696346	4843071	884	5.1
BADL	SM5	696550	4843380	881	5.4
BADL	SM6	694975	4843156	892	5.1
BADL	SM8	695043	4841632	917	7
BADL	SM9	695103	4840911	972	6
BADL	SM10	695363	4840159	972	6
BADL	SM11	695622	4839395	990	10
BADL	SM12	696031	4838739	998	5.8
BADL	SM13	696076	4838085	991	7.1

Appendix A, continued.

Park	Point number	Easting	Northing	Elevation (m)	Error (m)
BADL	SM14	695681	4837567	991	5.7
BADL	UW1	732298	4853079	823	4.7
BADL	UW2	731445	4853285	823	5.2
BADL	UW3	730832	4853649	829	5
BADL	UW4	730139	4854229	842	4.4
BADL	UW5	729559	4854625	851	4.4
BADL	UW6	728687	4854747	856	4.7
BADL	UW7	728008	4854813	871	5.6
BADL	UW8	727575	4855551	871	5.4
BADL	UW9	727099	4856006	-	5.1
BADL	UW10	727134	4856998	860	7.9
BADL	UW11	726765	4857476	861	7
BADL	UW12	726047	4857900	863	6.7
BADL	UW13	725688	4858525	868	6.5
HOME	1	0684201	4462006	387	5.7
HOME	2	0694278	4461828	382	5.2
HOME	3	0684503	4461732	387	6.9
HOME	4	0684676	4461599	396	5.7
HOME	5	0684496	4461449	387	8.1
HOME	6	0684230	4461472	390	6.1
HOME	7	0684005	4461489	384	5.8
HOME	8	0683826	4461472	382	5.9
HOME	9	0683649	4461393	383	9.4
PIPE	1	0714376	4877146	504	6.7
PIPE	2	0714401	4876897	504	7
PIPE	3	0714658	4876830	512	7.1
PIPE	4	0714888	4876851	521	6.3
PIPE	5	0714546	4876544	503	2.8
PIPE	6	0714277	4876279	501	3.1
PIPE	7	0714906	4876386	516	6.3
PIPE	8	0714052	4876940	502	5.8
SCBL	1	607879	4630896	1271	5.8
SCBL	2	607272	4631219	1265	7.3
SCBL	3	606494	4631706	1268	7.1
SCBL	4	605965	4632446	1232	7.2
SCBL	5	606451	4634008	1218	8.8
SCBL	6	607146	4633773	1227	6.2
SCBL	7	607635	4633622	1220	5.2

Appendix A, continued.

Park	Point number	Easting	Northing	Elevation (m)	Error (m)
SCBL	8	608248	4633462	1225	4.9
SCBL	9	608511	4633262	1221	4.5
SCBL	0S10	606342	4632641	1258	7.1
SCBL	OS5	608178	4632033	1298	5.9
SCBL	OS6	607977	4631753	1264	6.3
SCBL	OS7	607095	4631683	1300	5.1
SCBL	OS8	607005	4632127	1294	6.7
SCBL	OS9	606791	4632399	1277	5.3
SCBL	OT1	606302	4631426	1279	8.9
SCBL	OT2	606444	4631036	1289	4.6
SCBL	OT3	606419	4630644	1324	9.7
SCBL	R1	608101	4633874	1199	6.4
SCBL	R2	607983	4634076	1186	10
SCBL	R3	607600	4634203	1192	8.1
SCBL	SE1	608532	4629692	1287	12
SCBL	SE2	608840	4630100	1254	4.8
SCBL	SE3	608458	4630974	1235	8.1
SCBL	SE4	608722	4631369	1240	6.8
SCBL	SE5	608418	4631514	1247	8.5
SCBL	SE6	608344	4631307	1227	7.2
SCBL	SE7	607965	4631240	1249	7.3
SCBL	SE8	608872	4632203	1240	8.8
SCBL	SE9	608636	4632727	1240	8
THRO	1	628271	5194997	844	5.4
THRO	2	628254	5195776	841	5
THRO	3	628237	5196567	848	6.2
THRO	4	628223	5197352	854	7.3
THRO	5	628207	5198172	840	5.3
THRO	6	628195	5198948	839	5.2
THRO	ES10	624450	5273584	618	5
THRO	ES11	623907	5273935	611	5.3
THRO	ES9	624882	5272920	605	5.7
THRO	LL1	613365	5201128	685	6.5
THRO	LL10	616313	5205188	716	4.6
THRO	LL11	616904	5204829	729	5.2
THRO	LL12	617745	5204647	728	5.8
THRO	LL13	618424	5204383	733	4.3
THRO	LL14	618964	5203667	754	4.8
THRO	LL15	619396	5203157	760	5

Appendix A, continued.

Park	Point number	Easting	Northing	Elevation (m)	Error (m)
THRO	LL2	614083	5201203	690	5
THRO	LL3	614636	5201850	692	6.5
THRO	LL4	615088	5202409	696	4.9
THRO	LL5	614684	5203047	689	5.1
THRO	LL6	614820	5203788	699	6.1
THRO	LL7	615568	5203901	724	4.8
THRO	LL8	615076	5205033	712	4.4
THRO	LL9	615677	5205272	718	4.1
THRO	LR10	613153	5201105	680	6.3
THRO	LR11	613661	5200564	689	5.8
THRO	LR12	614295	5200159	724	6.9
THRO	LR13	615615	5198266	766	5
THRO	LR14	616071	5198055	772	5.4
THRO	LR15	618440	5196686	775	4.3
THRO	LR6	611820	5199179	762	6.5
THRO	LR7	611908	5199599	732	7.2
THRO	LR8	612008	5200112	714	7.4
THRO	LR9	612336	5200825	684	6.1
THRO	MS1	619596	5197447	759	4.6
THRO	MS10	623081	5200097	767	7
THRO	MS11	623007	5200930	772	7.8
THRO	MS12	622398	5201164	797	7.8
THRO	MS13	621801	5201699	837	6.8
THRO	MS14	621422	5202198	830	7
THRO	MS15	620160	5202743	757	5.4
THRO	MS2	619325	5198019	764	4.3
THRO	MS3	619511	5198758	729	4.4
THRO	MS4	620083	5199085	742	6.1
THRO	MS5	620708	5198618	760	5.6
THRO	MS6	621220	5198884	765	5.4
THRO	MS7	621983	5198976	762	5.3
THRO	MS8	622685	5199066	769	5.4
THRO	MS9	623343	5199365	751	6.6
THRO	NU1	630138	5273333	617	4.9
THRO	NU2	629534	5273388	617	6.6
THRO	NU3	620779	5272193	598	7.1
THRO	NU4	627897	5272115	627	7.8
THRO	NU5	627422	5272272	623	4.3
THRO	NU6	626890	5272687	640	4.4

Appendix A, continued.

Park	Point number	Easting	Northing	Elevation (m)	Error (m)
THRO	NU7	626290	5272631	626	4.1
THRO	NU8	625499	5272449	599	5.2
THRO	SS1	612076	5197884	725	4.3
THRO	SS2	612675	5197778	722	5.4
THRO	SS3	613591	5198418	753	6.6
THRO	SS4	612941	5198569	771	4.7
THRO	SS5	612284	5198811	773	5.8
THRO	WS12	623082	5274130	630	6.9
THRO	WS13	621747	5274941	744	7
THRO	WS14	621646	5275713	760	5.4
THRO	WS15	621007	5276001	760	6.1
THRO	WS16	620354	5276017	746	5.6
THRO	WS17	619467	5275982	734	5.6
THRO	WS18	618309	5275072	743	6.2
THRO	WS19	617740	5274758	745	4.7
THRO	WS20	617664	5274069	722	5.1
THRO	WS21	616902	5273924	718	6.8
THRO	WS22	616941	5273365	721	5.4
WICR	1	0464398	4106449	317	10
WICR	2	0464025	4105634	317	11
WICR	3	0463917	4104828	345	7.1
WICR	4	0463479	4105289	361	7.2
WICR	5	0463177	4106068	357	6.7
WICR	6	0463054	4106809	367	16
WICR	7	0462934	4107522	358	18
WICR	8	0463654	4107720	340	18
WICR	9	0464219	4107338	352	7.7
WICR	10	0464364	4105376	363	13
WICR	11	0464507	4104778	379	6.8
WICR	12	0464214	4104122	332	5.9
WICR	13	0462992	4104794	353	8.6
WICR	14	0463104	4104164	349	8
WICR	15	0463877	4104028	354	8.1
WICR	16	0463740	4106000	329	10
WICR	17	0464189	4107267	317	12
WICR	18	0463831	4107529	342	17

AGFO = Agate Fossil Beds National Monument, BADL = Badlands National Park, HOME = Homestead National Monument, PIPE = Pipestone National Monument, SCBL = Scotts Bluff National Monument, THRO = Theodore Roosevelt National Park, WICR = Wilson's Creek National Battlefield.

Appendix B. Sample datasheets for point count data.

ORIGINAL DATA SHEET

Observer_____ Date_____ Location_____

Point #	Time				Species				0 - 3 minutes			3 - 5 minutes		
									≤ 50 m	50-100 m	fly over	≤ 50 m	50-100 m	fly over

Appendix B, continued.

ESTIMATED DISTANCE DATA SHEET

Observer_____ Date_____ Location_____

Point	Time				Species				0 - 3 minutes			3 - 5 minutes		
									Total	Distance(m)	fly over	Total	Distance(m)	fly over

Appendix C. Information available on Northern Prairie Wildlife Research Center Web Site on the effects of management on grassland birds:
(http://www.npwrc.usgs.gov/resource/literatr/grasbird/grasbird.htm)

EFFECTS OF MANAGEMENT ON GRASSLAND BIRDS

These reports are a series of literature syntheses on North American grassland birds. The need for these reports was identified by the Prairie Pothole Joint Venture (PPJV), a part of the North American Waterfowl Management Plan. The PPJV recently adopted a new goal, to stabilize or increase populations of declining grassland- and wetland-associated wildlife species in the Prairie Pothole Region. To further that objective, it is essential to understand the habitat needs of birds other than waterfowl and how management practices affect their habitats. The focus of these reports is on management of breeding habitat, particularly in the northern Great Plains.

This resource is based on the following source:
Johnson, D. H., and L. D. Igl (Series Coordinators). 1998 (revised 2000). Effects of management practices on grassland birds. Northern Prairie Wildlife Research Center, Jamestown, ND.

This resource should be cited as:
Johnson, D. H., and L. D. Igl (Series Coordinators). 2000. Effects of management practices on grassland birds. Northern Prairie Wildlife Research Center, Jamestown, ND. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. Available from: (http://www.npwrc.usgs.gov/resource/literatr/grasbird/grasbird.htm)

ORGANIZATION AND FEATURES OF SPECIES ACCOUNTS

- Range Map: indicates the relative densities of the species in North America, based on Breeding Bird Survey (BBS) data.
- Capsule statement: provides the fundamental components or keys to management.
- Breeding range: outlines the current breeding distribution in North America.
- Suitable habitat: describes the breeding habitat.
- Table: lists the specific habitat characteristics for the species by individual study.
- Prey habitat: describes the prey requirements of predatory species.
- Area requirements: provides minimum area requirements for species exhibiting area sensitivity.
- Cowbird brood parasitism: summarizes rates of cowbird parasitism, host response to parasitism, and factors that influence parasitism.
- Breeding-season phenology and site fidelity: lists spring arrival and fall departure dates for the Great Plains and site tenacity.
- Species' response to management: summarizes the effects of different habitat management practices.
- Management recommendations: summarizes specific recommendations for habitat management.
- Literature cited: lists the references used in the species account.

Appendix C, continued.

SPECIES ACCOUNTS

Below is a list of species for which syntheses are available. These species accounts will be updated as necessary.

American Bittern
Mountain Plover
Marbled Godwit
Long-billed Curlew
Willet
Wilson's Phalarope
Upland Sandpiper
Greater Prairie-Chicken*
Northern Harrier
Swainson's Hawk
Ferruginous Hawk
Short-eared Owl
Burrowing Owl
Horned Lark
Sedge Wren
Loggerhead Shrike
Sprague's Pipit
Grasshopper Sparrow
Baird's Sparrow
Henslow's Sparrow
Le Conte's Sparrow
Nelson's Sharp-tailed Sparrow
Vesper Sparrow
Savannah Sparrow
Lark Sparrow
Field Sparrow
Clay-colored Sparrow
Chestnut-collared Longspur
McCown's Longspur
Dickcissel
Lark Bunting
Bobolink
Eastern Meadowlark
Western Meadowlark
Brown-headed Cowbird**

* not completed
** should be available 11/00

Appendix D. Draft protocol for monitoring birds on national parks.

NOTE: *This is a draft document from the National Park Service and has not been peer-reviewed by the U.S. Geological Survey, Northern Prairie Wildlife Research Center.*

Recommended Methods for Inventorying and Monitoring Landbirds in National Parks

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Key points in this document:

- Dozens of different approaches are used to sample birds in North America, and there is no single method that can be used to sample all species. Survey methods tend to be developed to sample groups of species that share common habitats (e.g., waterfowl, shorebirds), although some surveys are aimed at single species (e.g., piping plovers). Here, we focus on methods that sample bird in terrestrial habitats such as forests, grasslands and deserts, and provide references to sampling methods for other groups such as shorebirds and seabirds.
- As in all biological surveys, there are 2 general principles to consider:
- All areas for which you want information must have a chance of getting sampled by the survey, and survey results do not apply to areas that are not sampled.
- Biological survey methods tend to miss animals during the actual counts, as individuals and species are not detected by a simple count. Some sampling methods (such as distance sampling) allow for estimation of the detection rates, and others (such as simple point counts) do not. For most objectives, it is necessary to use methods that allow for estimation of the detection rates.
- The recommended method depends on the objective of the survey.
- If the purpose is simply to generate a checklist of birds in a park, the best approach is to have qualified observers go to all of the interesting areas in the park and record what they find using a "microatlas" approach.
- If the purpose is to get some idea of distribution by species and a qualitative assessment of relative abundance such as "abundant", "common", or "rare", then point counts or strip counts or some sort of index method are suitable.
- If the manager is interested in comparing bird abundance among species, habitats, or sites, or in determining trends in population size, then it is critical to implement additional procedures to ensure consistency over time and space, primarily by adding some measure of detectability, and we recommend distance sampling (line transect or variable circular plot [VCP] sampling) or double-observer (DO) methods.
- If the objective is to obtain information on primary demographic parameters or vital rates (productivity and survivorship) to help determine causes of bird population trends, we recommend constant-effort mist netting and banding such as used by the MAPS (Monitoring Avian Productivity and Survival) program.
- We do not recommend use of traditional (or unadjusted) point counts for estimation of abundance.
- In point counts, a single observer stands at a sampling point and records the number of individuals of each species heard or seen during a specified time period without any attempt to estimate detectability.
- Although this method is used in the North American Breeding Bird Survey (BBS), point counts cannot be reliably used to compare bird abundance among species, different habitat types, or among observers. Because surveys are done in many habitats by many observers in National

Parks, point counts will not provide acceptable information for the GIS applications and other likely uses of bird data.
Appendix D, continued.

- We recommend that point count protocols can be modified using VCP or double-observer methods to allow estimates of detectability for many species and yet still allow comparisons to historical data obtained with unadjusted point counts.
- Use of methods that allow for estimation of detectability are recommended for projects funded by the NPS Inventory and Monitoring Program. We think that the improvement in the quality and credibility of data compared to that obtained by unadjusted point counts more than justifies the increase in cost and effort required to incorporate an estimate of detectability.
- Distance sampling or the double-observer approach are the default methods. Any proposal to use unadjusted point counts or some other index method when the objective is to compare differences among species or provide population trend information must provide good justification for why the better methods cannot be used.
- Although distance sampling requires additional training and is not a panacea for all species, it can and is being done throughout the country in many types of habitats.

Introduction

Birds are an important component of park ecosystems, and their high body temperature, rapid metabolism, and high ecological position in most food webs make them a good indicator of the effects of local and regional changes in ecosystems. Moreover, birds have a tremendous following among the public, and many parks provide information on the status and trends of birds in the park through their interpretive program. More than 650 species of birds breed in North America. Most common survey methods allow simultaneous collection of information about species that share a common life history or habitat, but no single method will adequately sample the diversity of either habitats that birds occupy or life history groups such as seabirds, songbirds, raptors, and shorebirds all bird species. Hundreds of different sampling approaches have been used to quantify status or trend of bird populations, and dozens of different monitoring programs are currently in place throughout North America to determine local, regional, or national trends in bird numbers. The website http://www.mp1-pwrc.usgs.gov/ birds.html has information on 20 different bird monitoring programs used in North America.

The purpose of this document is to help busy natural resource managers in national parks (and their contractors and cooperators) find the most appropriate methods for inventorying and monitoring bird populations in the hopes of developing some consistency in bird sampling approaches among parks and regional efforts. The appendix lists some recommended methods and sources of additional information for surveys of raptors, shorebirds, marsh birds, and colonial-nesting birds, but our focus is on methods that are appropriate for simultaneously sampling a large number of terrestrial bird species in a variety of habitats such as forests, deserts and grasslands. We identify some of the problems with existing programs that should be avoided, and highlight some of the promising, recent developments in the art and science of bird counting that people may not be aware of.

We think that it is especially important to use consistent methods to sample birds so that data can be compared among parks and to samples taken outside of parks. Sample sizes for bird surveys in parks will usually be small because of limitations of personnel and funding, and comparison with other sites will help put the park's data in context and may help to interpret the results. Because of the annual variability in most biological indicators, it may require 10 or more years of data to identify population trends. By adding the spatial dimension (comparisons to other locations) to the temporal dimension (repeated surveys over time), it may be possible to identify patterns sooner, and to develop partnerships to respond to problems that are identified.

In the next sections, we identify 4 general objectives, and discuss approaches to meeting the objectives. In our view, any survey must be reviewed in light of 3 primary concepts: (1) Objectives – to adequately develop a survey, some goal must be clearly stated so that the design

can be specified and a clear product will be produced that can be evaluated by predefined criteria; (2) Sampling Frame – to conduct a statistically valid survey, you have to randomly select
Appendix D, continued.

samples from a list of all possible samples. The list is called the sampling frame. This sampling frame defines the area to which your survey actually applies, and must be defined as part of the survey development; and (3) Detectability – we miss birds during counting, and to conduct a credible survey we either have to assume that the number missed does not vary over space and time or we have to incorporate some method of figuring out how many birds are missed. For each objective, we briefly note some of the issues associated with sampling frames and detectability.

Objective 1: The goal of the survey is to simply document which species occur in the park.

The recommended approach here is to have qualified birders go to different areas of the park and record which species they find there to produce a checklist. A good inventory usually requires multiple visits and methods at different times of the year in order to document the rare species that are often of greatest interest. A fairly complete inventory may require considerable effort to survey all habitats and different seasons to increase the chance of detecting most species that occur in the park.

The park must provide some structure to this effort to ensure that the information will be credible. The following should be kept in mind as you plan the inventory: (1) Evaluate and document the skill level of each observer - Observers should be able to identify all birds that might be seen in the park; the success and credibility of the survey will depend on using well-trained, experienced observers; (2) Record keeping – survey data including species encountered, locations, dates, evidence of breeding status, and other relevant information must be appropriately stored in computer files; (3) Taxa and habitats of interest must be adequately surveyed - as in all surveys, if some areas (or species groups) are not sampled, we cannot claim to have surveyed them.

To ensure adequate and extensive coverage, we recommend that a "sampling framework" such as a grid or some other map-based areas be developed, and that sampling be encouraged in all areas. A grid (such as UTM cells) could be placed over the park, and observers asked to keep separate lists for each cell in the grid. In that way, information can be integrated with other park data using the park GIS at the scale of the grid cells. Other possibilities for collecting information at more local scales include defining areas (strata) for surveying based on permanent features such as roads, trails, rivers, or other features. We also suggest that particular habitats and species groups be targeted for special counting effort.

Estimating Total (and Relative) number of Species - Of course, no one will count all species, and it is difficult to figure out how much sampling is sufficient to get a good species list. One approach is to use statistical procedures with checklist data to estimate the number of species missed (i.e., the detectability of species) during counting. These procedures, which have been applied to bird count data (e.g. Boulinier et al. 1998), are based on capture-recapture methods, in which a "capture" is a species seen by a birder and the total number is estimated from the pattern of species' occurrences among birders. Using these procedures, it is possible to calculate species richness for the park, or for different strata within the park (e.g., different vegetation types or elevation zones; see the paper by Nichols and Conroy 1996). The programs CAPTURE and SPECRICH, available at http://www.mbr-pwrc.usgs.gov/software.html, allow you to enter data from one or more surveys and calculate species richness online. These procedures do not identify species that are not seen, but they do provide an estimate of the number of species that have not yet been encountered but are likely to be present. This allows an assessment of the adequacy of the sampling that has been conducted (e.g., have you recorded 90% of the species that occur in the park?)

To estimate species richness for the entire park or for different strata within the park, you should have people with similar skill in detecting birds visit each of the areas of interest and generate a checklist using some standardized approach that will ensure that they could encounter all the targeted species. Each observer must be capable of identifying each species, and each species

must have some chance of being detected. Hence, to survey a subset of species such as nocturnal birds or marsh birds (that only call at night or when stimulated by playback of recordings), all Appendix D, continued.

checklist participants must maintain a protocol that would allow them to encounter the species. Generally, 5 replicate checklists are needed for each sample site to apply the statistical estimation procedures (Nichols and Conroy 1996).

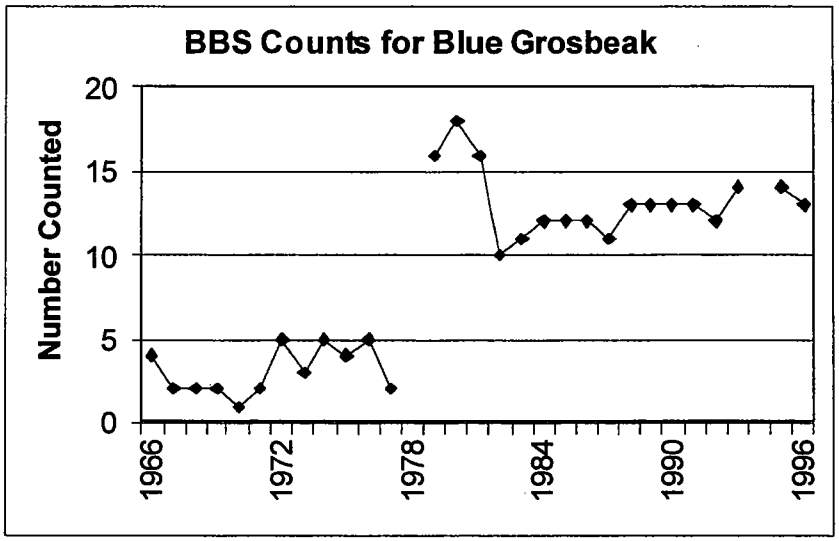
Objective 2: The goal of the survey is to determine distribution and get a qualitative measure of relative abundance ("abundant", "common", "rare") of each species in the park.

There are many different ways to generate distribution maps using either direct sampling or modeling approaches, but in each case it is important to develop a statistical sampling design that allows inferences to be made beyond the areas actually sampled. The document "Guidance for the design of sampling schemes for inventory and monitoring biological resources in national parks" available at http://www.nature.nps.gov/sfancy gives some examples of how to select sample sites such that data from those sites can be used to make inferences to specific strata or the entire park.

One method appropriate for this objective is the standard (or "unadjusted") Point Count, in which an observer stands at a predefined location and counts birds with a specific protocol. The Point Count method is currently the most common method of monitoring birds, and is used in the BBS, National Wildlife Refuge monitoring programs, National Forest monitoring programs (e.g. Manley et al. 1995), and to assist management efforts associated with Partners in Flight (Ralph et al. 1995). Counts are usually most effective during the breeding season, when singing rates are higher. Details of the method and field data forms are available in Ralph et al. (1995).

Point counts provide a great deal of information, and are generally easy to implement. They can be used to estimate species richness by strata, and the results can be used to classify the relative abundance of each species into categories such as "abundant", "common", "uncommon", and "rare". Standardization of methods and observer training is essential in ensuring some level of comparability of results. The difficulty with point counts is that people often use the results as a measure of differences in bird population size over time or among locations. Unfortunately, the number of birds that are counted at a sampling station is actually a combination of the number of birds that are actually there, and the proportion of them that you detect. Many people interpret differences between two point counts as the difference in number of birds, when in fact the difference may be caused entirely by differences in detectability. Without a measure of detectability, counts of birds are an unreliable measure of differences in the actual number of birds present. Burnham (1981) wrote that "Without estimating detection probabilities, the use of counts as indices of abundance is scientifically unsound and unreliable". Barker and Sauer (1995) found that the incomplete counts obtained by point counts "can bias estimators and testing procedures, leading to inappropriate conclusions. A large portion of the variability in point counts is caused by the incomplete counting, and this within-count variation can be confounded with ecologically meaningful variation". Nichols et al. (2000) wrote that "We believe that most questions meriting the effort required to carry out point counts also merit serious attempts to estimate detection probabilities associated with the counts". We concur.

An example of the problem is shown in the following count data for Blue Grosbeak along a Breeding Bird Survey route:



The counts of Blue Grosbeak obtained on this BBS route suggest that the population has increased during the 30-year period of 1966-1996, with a major population increase between 1978 and 1982. However, based on data from other BBS routes and various studies, there is no indication that the Blue Grosbeak population has actually increased. The pattern of counts shown above may have resulted entirely from changes in observers that ran this particular BBS route. The counts between 1966 and 1977 were obtained by one observer, then another observer ran the route in 1979 and in 1981-1984, a third observer did the 1980 count, a fourth observer did the 1986 count, and a fifth observer did the 1995-1996 counts. The apparent quadrupling of the population between the 1960s and 1980s was apparently due to the observer change, which numerous studies have shown is a major problem with bird surveys. Observer effects such as this are accommodated in the BBS analysis of population change through use of covariates (i.e., change is only estimated within an observer's data), but even in a survey as consistently run as the BBS there are important unresolved issues associated with our inability to distinguish real population change from changes associated with observers, weather, and other factors that have nothing to do with the population.

Differences in detectability can lead to misleading results even when the same observer conducts all of the point counts. To give a simple example, let us say that the average count for Species X in spruce forests is 2.0 birds/count compared to 4.0 birds/count in open shrublands, suggesting that the species is twice as abundant in the shrublands. However, if the probability of detecting the species in spruce forest is lower because you can't see as far and can't hear as far, then the true difference in abundance between the two habitat types may be very different, and the raw counts are a misleading measure of relative abundance. The same is true when comparing one species to another: some species are more showy and vocal than others, resulting in higher counts, and yet the more cryptic or quiet species may actually be more abundant. Unfortunately, remarkably small differences in detectability (e.g., < 9%) can lead to statistically significant differences in counts (Sauer and Link, in press). Without a measure of detectability, point counts can always be criticized when used to compare differences in abundance among species, habitats, different time periods, or places. The counts can, however, be used to obtain information on distribution and to assign qualitative measures of abundance to a species such as "lots of them" or "very few of them".

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Note: These comments just begin to touch on an important controversy in biological sampling. Estimation of detection rates is considered by statisticians to be essential in any sampling that is not a "census." As biologists with field experience, we are sympathetic to the need to develop feasible methods. However, it is essential that the information be scientifically credible and defensible so that it can be relied upon to make resource management decisions. In our view, point counts that do not incorporate some procedure for estimating detectability do not meet this standard.

One common modification of point counts is to play recorded calls to increase probability of detecting rare or secretive species such as marsh-breeding or nocturnal species. Sample protocols for these species are referenced in the Appendix. Because the number of species encountered in these surveys is usually quite small, it is difficult to apply the statistical methods for estimating species richness, and the counts of both species and relative abundance of species are used as the dependent variables. It may be practical to include the playback procedures at a subset of points in habitats appropriate to the targeted species. Broadcasting the taped calls after the standard count period could increase the chance of detecting the targeted species.

Objective 3: The goal of the survey is to compare relative abundance among species, habitats or areas, or to detect trends in population size.

As indicated in #2 above, the number of birds you count at a sampling station is a combination of the number that is actually there and the proportion of them that you detect during the count. Very rarely do you count all of the birds that are actually present, and to meet the objectives stated in #3 you need to estimate the proportion of birds that you miss. We recommend that you use one of two methods to meet this objective: either Distance Sampling or the Double Observer Approach. Each is explained below, with greater emphasis on Distance Sampling because it is the most established of the two and can be conducted by only one person.

Distance Sampling.

Distance sampling, which includes both line transect sampling and variable circular plot (VCP) counts, has been used for more than 30 years to estimate animal abundance and for most sampling situations is the best method currently available for determining relative abundance or trends for most bird species. In practice, the method is basically the same as unlimited distance point counts, except that for each bird heard or seen during the count, its horizontal distance from the observer is estimated. In the case of line transect sampling, the observer walks down a transect and records either the perpendicular distance to each bird heard or seen, or else records the sighting angle and sighting distance instead of the perpendicular distance. Variable circular plots are a type of distance sampling where the observer stands at a sampling station and records the horizontal distances between the observer and each bird. Line transects are usually more efficient than VCP counts where they can be conducted because you continually collect data as you walk down the transect, whereas during VCP counts you count birds only from stations located every 250 m or some interval along the transect. However, VCP counts are the preferred approach in patchy habitats if you want to associate bird data with vegetation or other habitat information, and in dense, rugged or hazardous terrain where you need to watch your footing as you walk down the transect. Another advantage of VCP counts is that the data can be directly compared to historical point count data such as from BBS counts and can contribute to ongoing programs such as the National Point Count Database.

Distance sampling is currently being used to sample birds in various national park settings throughout the country. VCP counts have been used to sample birds in parks in Hawaii for more than 20 years, and several field tests have been conducted in Hawaii that validate the method (e.g., Fancy 1997, Nelson and Fancy 1999). Channel Islands NP has been conducting line transect sampling and VCP counts to monitor landbirds since 1993, and VCP counts are currently being used for bird inventories in Yukon-Charley NPP and Great Smoky Mountains NP. We need to

emphasize, however, that although distance sampling generally does improve estimates of abundance and population trends for many species, it is not a panacea and there are a number of

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limitations of the method even with the best trained and most highly skilled observers. For example, in many surveys, the majority of birds are heard but not seen, and the observer estimates the distance to a tree or bush or other object where they think the bird is hiding. Distances cannot be estimated accurately in many situations because of habitat complexity or ventriloqual bird voices or other reasons. Also, more than 100 detections may be required to develop a good detection function for each species, such that multiple surveys of the same area will be required for all but the most common species in order to get adequate sample sizes.

Occasionally, there are detectability issues in bird sampling that VCP and other estimation procedures cannot address. For example, there may be unobservable portions of the population (such as females) that are not detected at all during counting. Or, it may be impossible to estimate detectability at the appropriate scale, for example when habitat-specific detectability exists in a rare species. Thus, even with a measure of detectability factored into estimates derived from counts of birds, such estimates may still be an unreliable measure of differences in the actual number of birds present in some situations. Interpretation of survey data requires a sensitivity to these extra-statistical limitations of the estimation procedures.

Nevertheless, we recommend distance sampling as the best method currently available for meeting this objective of collecting abundance or trend information. There have been a number of recent developments with distance sampling that now make it easier to implement both in the field and with data analysis:

- The book "Distance sampling: estimating abundance of biological populations" by Buckland et al. (1993) provides a good background of the theory and specific details of distance sampling.
- Distances do not have to be estimated exactly in the field as some earlier reports suggested. Distances that are recorded as accurately as possible in the field can then be placed into distance intervals and analyzed as grouped data, such as 0-16 m, 17-32 m, 33-48 m, etc. When data are analyzed in distance intervals, there is no error as long as the estimated distance to the bird is placed in the correct interval. Laser rangefinders are now available in the $200 to $300 range that can measure the distance to a rock or tree within 1% accuracy, and these can be used in certain situations for training and to improve distance estimates during counts (distances to various references points around each sampling station can be estimated prior to the start of the count).
- Data from repeated surveys of the same area or areas with similar habitat characteristics can be combined to increase sample sizes. By combining surveys, it is possible to estimate densities of many rare species, even in situations where only 1 or 2 birds are detected while sampling 30-40 stations.
- It is possible to adjust for different covariates such as the observer effect, and effects of dense vegetation or weather on detection distances. Version 4 of the DISTANCE program will allow you to model covariates directly in the software.
- It is still possible to use historical count data collected using unadjusted point counts if a park switches to VCP counts but records the number of birds detected during the same duration of sampling. For example, if you have been running a BBS route in the park for 20 years, you can still make direct comparisons between the new data if you conduct VCP counts and record detections made during the first 3 minutes with the old data for each sample location and species. To compare with historical 5-minute point counts as well as BBS data, you could record those birds detected during the first 3 minutes, and then indicate those detected in the next 2 minutes of a 5-minute count.
- Version 4 of the DISTANCE software, due out in Fall 2000, will have a number of features specifically designed to make it easier to analyze bird count data. It will be possible to program a data entry form that matches your field form to make it easier to enter data into the program. The software will allow you to combine data from multiple surveys, and covariates such as different

observers can be modeled directly in the program. The software will be free, and a number of people in the National Park Service or partner agencies will be trained to analyze data – you do not need to be able to analyze your data to use this method.

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- The NPS I&M program is in the process of developing materials to help parks implement distance estimation in parks, including data forms, training materials, and assistance with data management and analysis. Check the website http://www.nature.nps.gov/sfancy after June 2000 for information and examples that are available.

Double-observer Counting

Double-observer counting provides an alternative method of modifying point counts to incorporate detectability information. In this procedure, two observers count at each point. One observer is the "primary," who counts all birds they see or hear. A "secondary" observer records the birds detected by the primary observer, but also notes any birds missed during counting by the primary observer. The two observers alternate roles between points, so that for any area of interest the data will have replicate points at which each observer was primary. Using these data, the proportion of birds missed by each counter can be estimated (Cook and Jacobson 1979, Nichols et al. 2000). This procedure has only recently been implemented for point counts, but it appears to provide reasonable results (Nichols et al. 2000). A few comments:

- General protocols for point counts, such as standardized criteria for duration and conditions for counting, can be followed for both double-observer and VCP counts. However, both procedures greatly enhance the quality of the information from the counts, by allowing for estimation of detectability. Double-observer counts also have intrinsically-higher detection rates than unadjusted point counts, simply because two observers are counting.
- Double-observer methods require that birds be counted within a fixed radius to allow a rigorously-defined area for estimation of density. The fixed radius also eliminates the possibility that differences in detectability between observers represents differences in area counted by observers.
- Detectability can only be estimated when both observers have counted as primary observers. Consequently, if habitat-specific detection rates are needed (and they generally are needed), it must be ensured that sufficient replicates exist within each habitat type to allow each observer to be primary at more than one point.
- Sample field sheets and specific protocols for a double-observer study are available on request from the USGS Patuxent Wildlife Research Center.
- Computer programs exist for estimation of detection rates from double-observer surveys (J. E. Hines, USGS Patuxent Wildlife Research Center, Laurel, MD).

General Comment on Detectability Estimation

Bird surveys tend to be omnibus, in that the survey is designed to count many species at the same point. Unfortunately, this limits our ability to modify the surveys to increase the efficiency for any particular species. Consequently, most surveys collect good information for a few species, and relatively poor information for many species. This is not a reflection of the quality of the estimation procedure, but instead reflects the lower quality of all information for these low abundance species. This should be a warning sign for any use of the data for those species, not just for the estimation of detectability.

Objective 4: The goals of the monitoring effort are to aid in determining the causes of population trends and differences in abundance among species, habitats, and areas; and to identify and evaluate management actions to reverse declining trends and increase low population sizes.

The use of point counts that include measures of detectability can provide estimates of abundance or density of landbirds, and can facilitate analyses to determine population trends and differences in abundance among species, habitats, and geographic areas. These methods, however, fail to provide data on the primary demographic parameters or vital rates (productivity and survivorship) of landbirds. Without data on vital rates, it is difficult to test competing hypotheses to

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account for observed population changes, or even to determine the stage(s) in the life cycle at which population change is taking place; that is, whether the change is being driven by causal agents that affect birth rates or death rates or both. This information is critical for most landbird species, especially those for which death rates are driven primarily by factors operating on their wintering grounds, often thousands of kilometers removed from their breeding grounds.

Monitoring the vital rates of landbirds allows the construction of demographic models to assess the viability of populations, aids efforts to identify management actions to reverse population declines, and facilitates evaluating the effectiveness of those remedial management actions. This is because environmental stressors and management actions affect vital rates directly and usually without the buffering or time lags that often occur with population trends. Moreover, habitat- and landscape-specific data on vital rates provide a clear index of habitat and landscape quality, and can identify population sources and sinks.

The technique of constant-effort mist netting and banding is a tested and proven method for collecting information on vital rates of landbirds. Annual indices of productivity and adult population size are obtained from analyses of data on the numbers of young and adult birds captured; annual estimates of adult survival rate, adult population size, proportion of residents in the adult population, and recruitment into the adult population are obtained from modified Cormack-Jolly-Seber analyses of mark-recapture data. The technique has been in standardized use since 1982 in the British Constant Effort Sites Scheme, and since 1992 in North America in the Monitoring Avian Productivity and Survivorship (MAPS) Program. MAPS protocol is currently used in both Denali and Shenandoah National Parks as part of their Long-Term Ecological Monitoring (LTEM) efforts, and 37 MAPS stations are currently being operated in 17 NPS units nationwide. The standardized nature of MAPS data and the continental scope of the program, with over 500 stations operated annually, means that data on vital rates of landbirds from NPS units can be directly compared to each other and to data from >100 stations on national forests, >100 stations on DoD military installations, and >270 stations on other federal, state, and private landholdings.

A MAPS station includes a permanent array of about ten mist nets located in the core eight hectares of a 20-ha study area. MAPS protocol includes the standardized operation of these nets for about six morning hours during one day per 10-day period, for six to ten (depending on latitude) consecutive 10-day periods between May or early June and early August. All birds captured are identified to species, age, and sex and, if unbanded, are banded with USGS/BRD numbered bands. Additionally, the apparent breeding status of each species encountered at the station is determined each year, and habitat structure within and surrounding the station is assessed according to a standardized protocol. These combined protocols allow landscape-level demographic data for a whole suite of landbirds species to be collected in a cost-effective, nationally standardized manner.

An integrated approach to monitoring both vital rates and population trends of landbirds, and relating them to habitat characteristics across the landscape, is critical for determining causes of population changes and for identifying, as well as testing, management actions and conservation strategies to reverse population declines. The most effective and useful avian monitoring programs will be those that incorporate multiple, complementary approaches —population distribution and trend monitoring through VCP point counts, and determination of vital rates through constant-

effort mist netting. Finally, avian monitoring efforts should be conducted in conjunction with assessments of the habitats on which targeted bird communities depend, to provide insights into the ecological correlates of declining or increasing populations. Ideally, appropriate habitat assessments should be coordinated with other park monitoring programs, so that effort is not repeated, and data on a variety of taxa and ecological processes throughout the park can be readily integrated.

Appendix D, continued.

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Sources of information for monitoring other bird groups

Many regional and national monitoring programs exist for taxa of management interest. Here, we provide references for some of the techniques and protocols used for these programs. It is important to recognize that these procedures often do not conform to the principles of survey design stated in this document, especially when local managers take the information and attempt to implement the methods for local areas. Instead of providing sampling frames useful at local scales, they tend more often to provide information that can be aggregated at regional scales. Detectability is often not estimated as part of these surveys, a reflection of the emphasis on estimation of temporal change rather than spatial pattern. We suggest that the protocols used for these taxa be reviewed before use to ensure that they will provide information relevant at the scale of a National Park.

Hawks: Fuller and Moster (1987, Raptor survey techniques. Pages 37-65 in Raptor management techniques manual, National Wildlife Federation, Washington DC). The tape playback method works fairly well for breeding woodland hawks, but is rather labor intensive. Their methods for non-breeding surveys are the current "standards", but undoubtedly have problems with detectability issues. A "Report of a Workshop to Develop a North American Raptor Monitoring Strategy" is available at http://www.mp1-pwrc.usgs.gov/raptor/ raptor.html .

Shorebirds: A standardized monitoring protocol to collect, compile, analyze, and disseminate information about shorebird population trends, distribution, and abundance is being developed. The report "A Comprehensive Monitoring Program for North American Shorebirds" can be downloaded from http://www.manomet.org/USSCP/files.htm

Marsh Birds: Secretive marsh birds are difficult to detect and inhabit areas that are often not readily accessible. Therefore, they are poorly surveyed by the Breeding Bird Survey and other existing monitoring programs. A number of efforts have been made to standardize marsh bird surveys using taped playback response. Notable among these is the work by Gibbs and Melvin (1993. J. Wildl. Manage. 57: 27-34) and the Long Point Bird Observatory's (LPBO) Marsh Monitoring Program (1996, Marsh Monitoring Program Training Kit and Instructions). See http://www.mp1-pwrc.usgs.gov/marshbird/ to download copies of workshop reports and obtain information on efforts to develop consistent methods for monitoring marsh birds.

Colonial Waterbirds: The USFWS, USGS, and state agencies are collaborating to create a system of periodic inventories of colonial waterbirds in the United States. See http://www.im.nbs.gov/cwb/cwb.html.